Warfighter Visualization

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The DARPA Warfighter Visualization Program was initiated in fiscal year 1997 and the first 3 contracts for the Phase I effort were signed in May 1997.

The Warfighter Visualization Program seeks to develop a significant improvement in situational awareness for individuals and small units operating on the battlefield.

Warfighter Visualization

DARPA

Program Goal: Overcome space, time, and physics to visualize and operate in real world.

This program will enhance individual warfighter situational awareness and decision making ability by providing unique ways of receiving and interacting with spatially correct, timely information in both individually served and shared environments. Focus areas are:

- Visually Coupled Systems
- Geospatial Registration
- Enhanced Human Interfaces

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The goal of the program is to enhance individual warfighter situational awareness and decision making ability. The battlefield is a data rich environment and while much of this data can be gathered, processed and acted upon in tactical operation centers, little of this information is available in a timely fashion to individuals and small teams in the field. This program focuses upon developing technology and techniques that provide a visual coupling from sensors to the eye that are geospatially correct and timely. The three main challenges are: 1) to collect data from a variety of sensors (initially focused upon optical cameras from locally controlled airborne assets) and provide mechanisms to display processed information to the warfighter; 2) annotate the user's view of the real world with geospatially correct representations; and 3) to provide this information in a manner that is easily understood and acted upon.

Warfighter Visualization

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Visualization assets that are owned, deployed, and operated by individuals and small teams.

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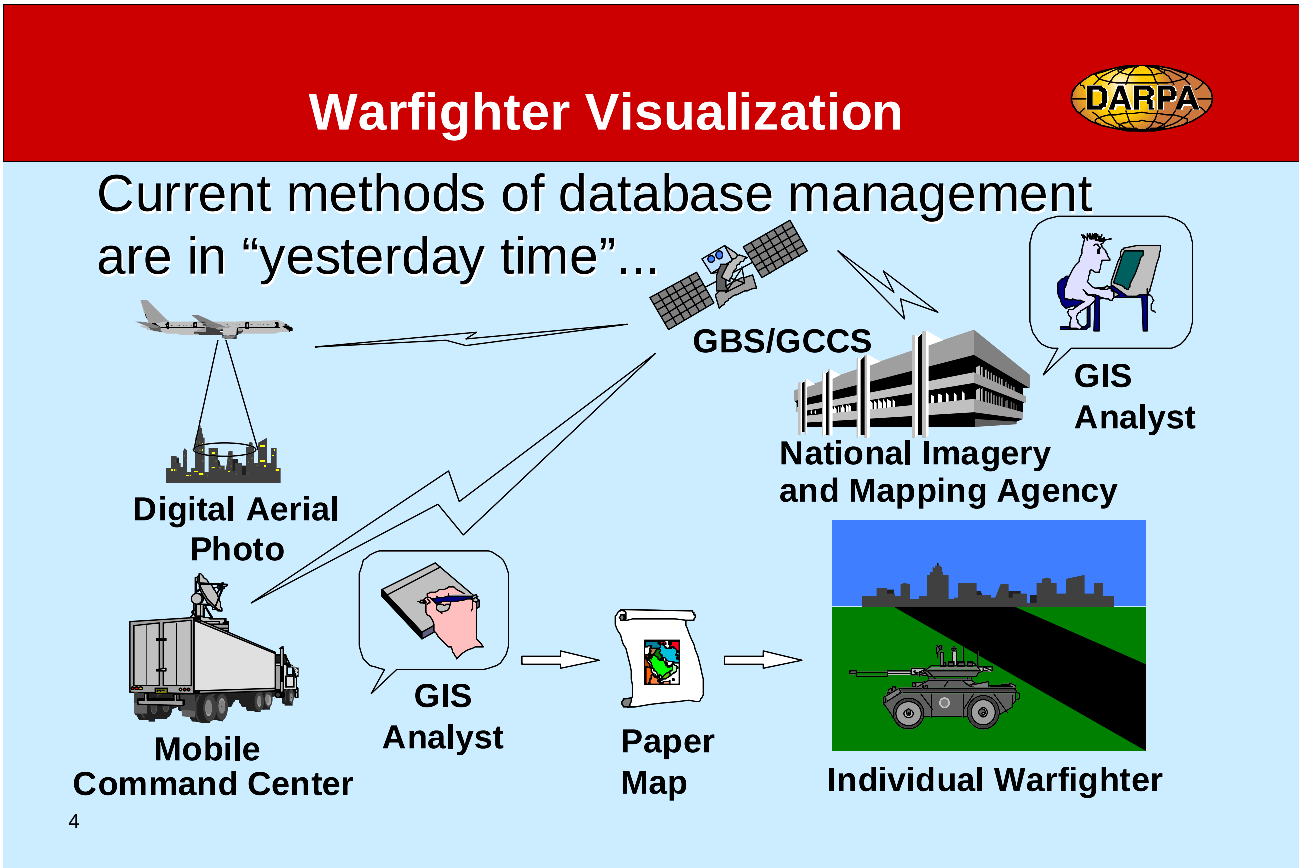
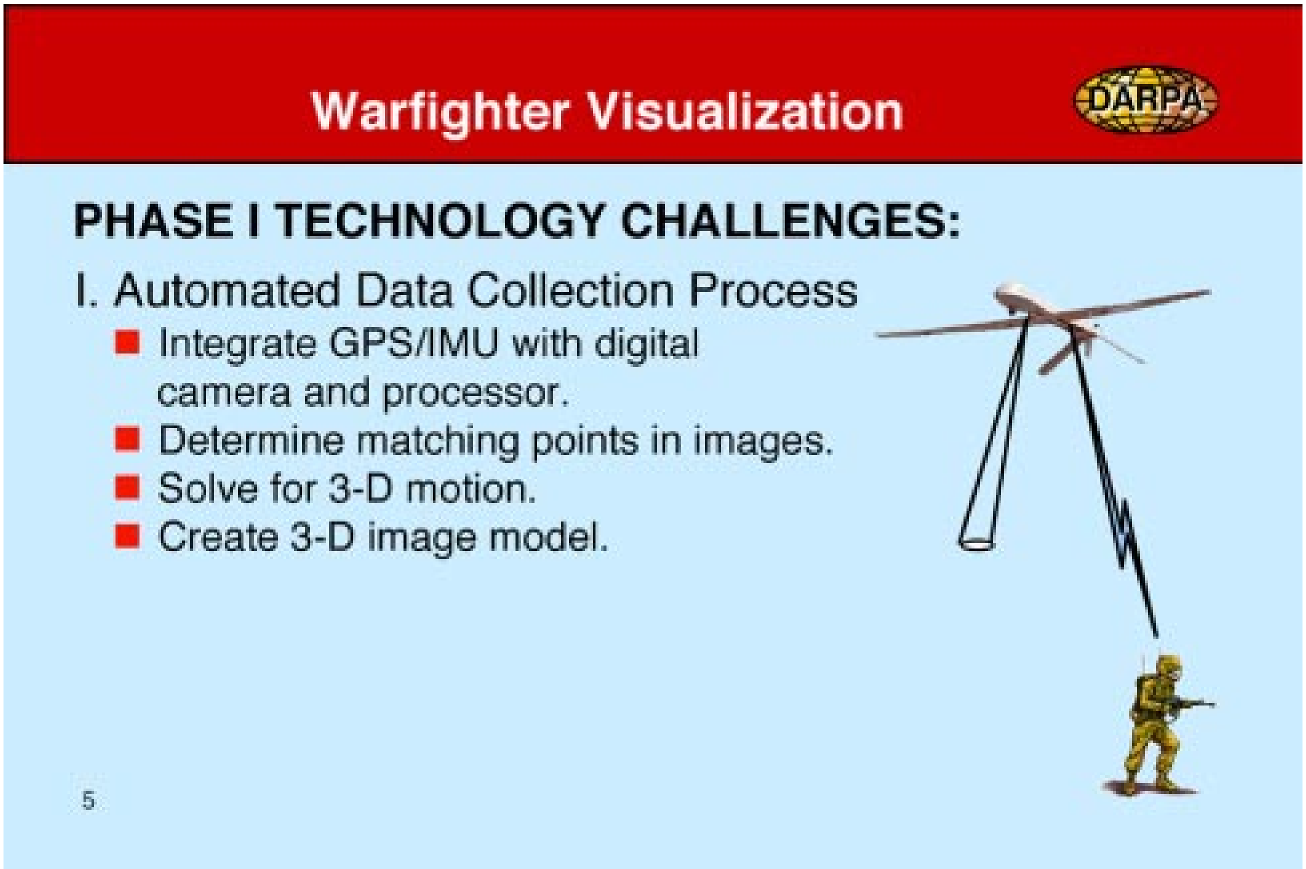
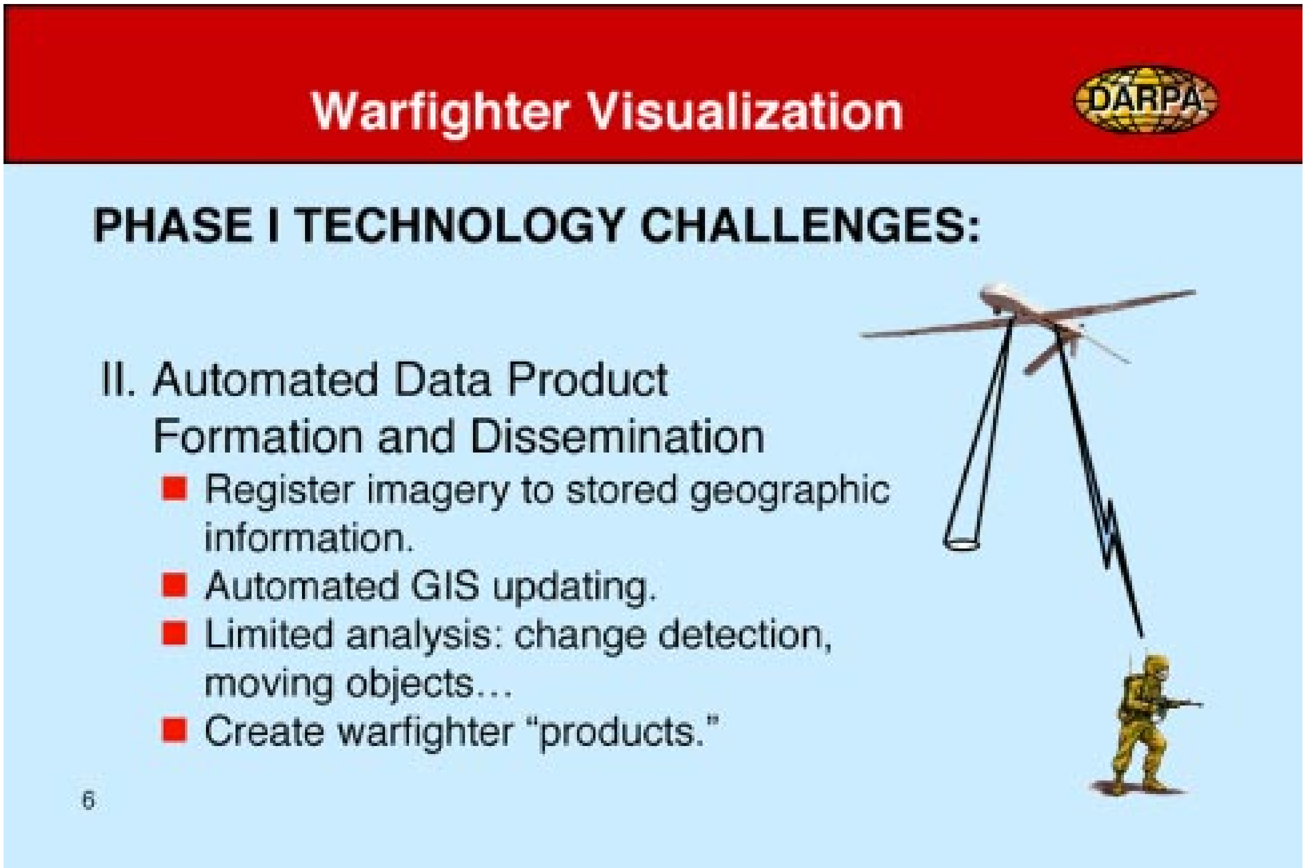
While the future warrior will be connected into the battlefield information infrastructure as both providers and users of information, this program focuses upon providing individuals and small teams information that is very specific to their tactical situation and that is not available in a timely fashion from upper echelon sources. Visualization assets that can be owned, deployed and operated by individuals and small teams are an important element of this program. A major challenge is to provide these assets in a small, lightweight, energy efficient and cost effective manner.



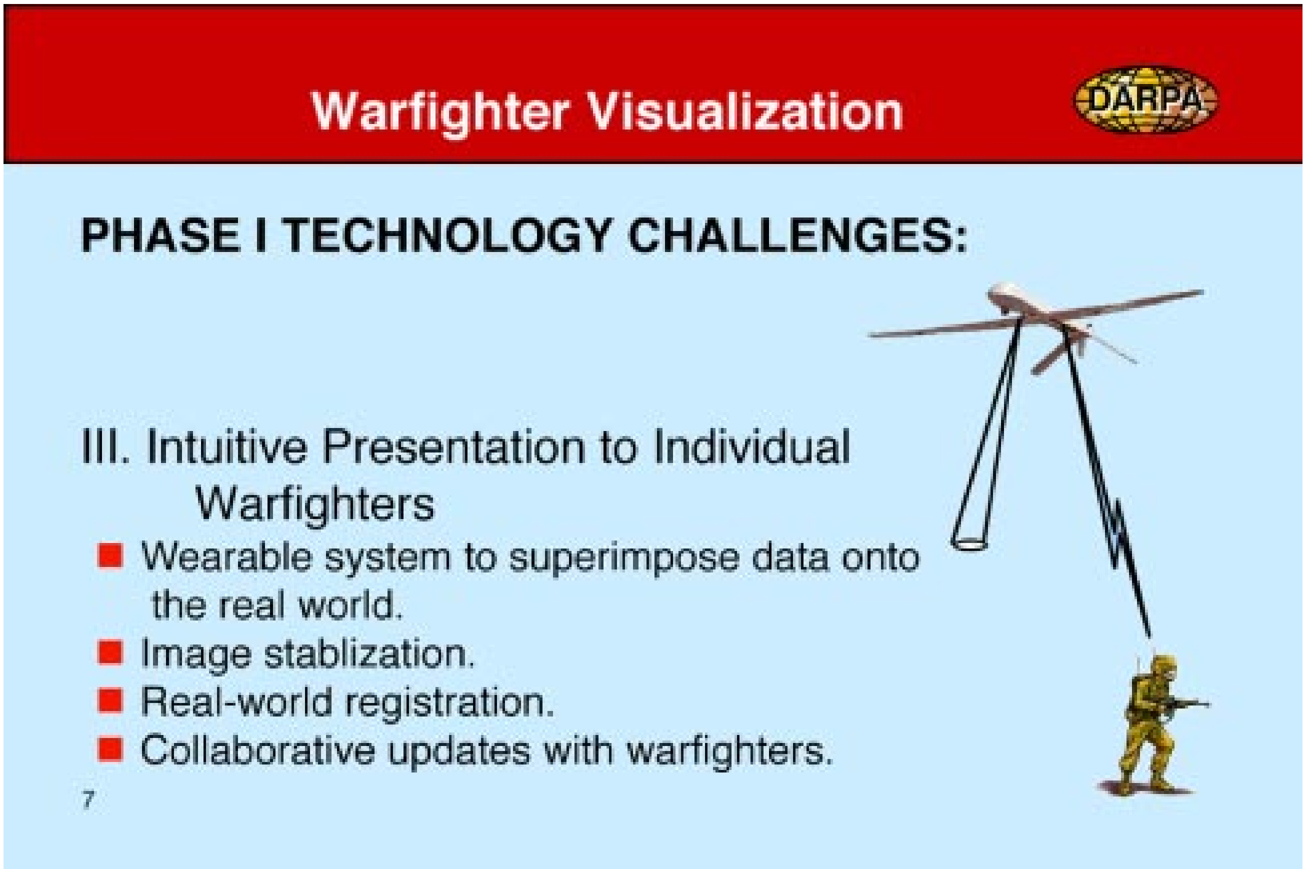
"Yesterday time" refers to the current method of gathering tactical information, processing that information with analysts in the loop, and providing it to the individual warfighter. In this example, photographs of terrain and features are collected by satellite or aircraft and sent to central locations for interpretation by analysts. The analysts transform the information from one media to another and deliver it through various organizational infrastrucutres to the warfighters. This information can be sent in a variety of formats but the most commonly used formats are paper and voice. This system is not timely, is often generalized for many users, is not tailored to specific user needs and is not interactive. We need to overcome "yesterday time" by providing timely, domain-specific, automated information whose collection, analysis, and presentation are controlled by the user.



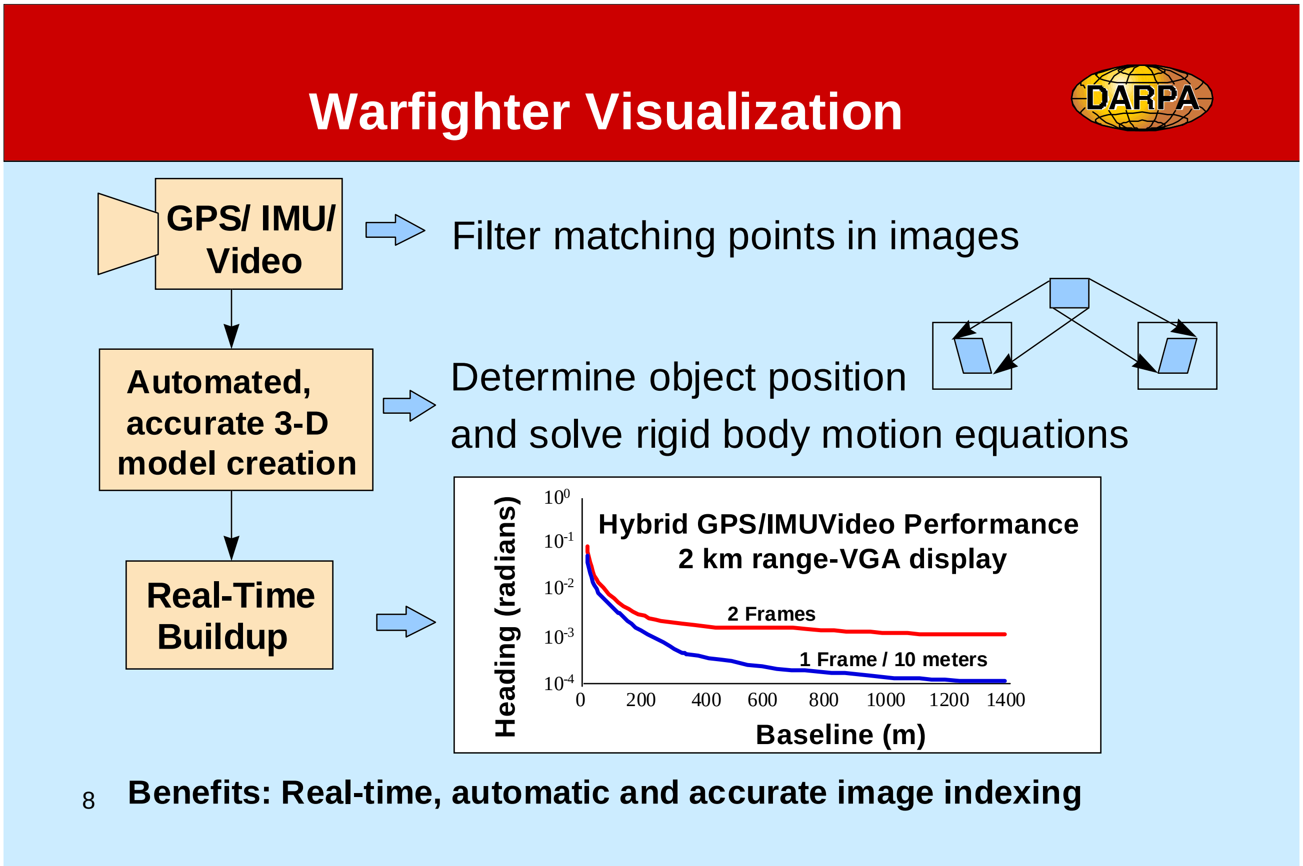
Phase I of the Warfighter Visualization program automates the data collection process and data product formation and dissemination process, and develops intuitive presentation of information to individuals. In the automated data collection process we will integrate a global positioning system receiver with an inertial measurement unit and image processor. This will allow us to obtain accurate fixes on ground objects as well as obtaining elevation data. After solving for 3-D motion, we can create a 3-D image model with all x, y, z coordinates for all features.



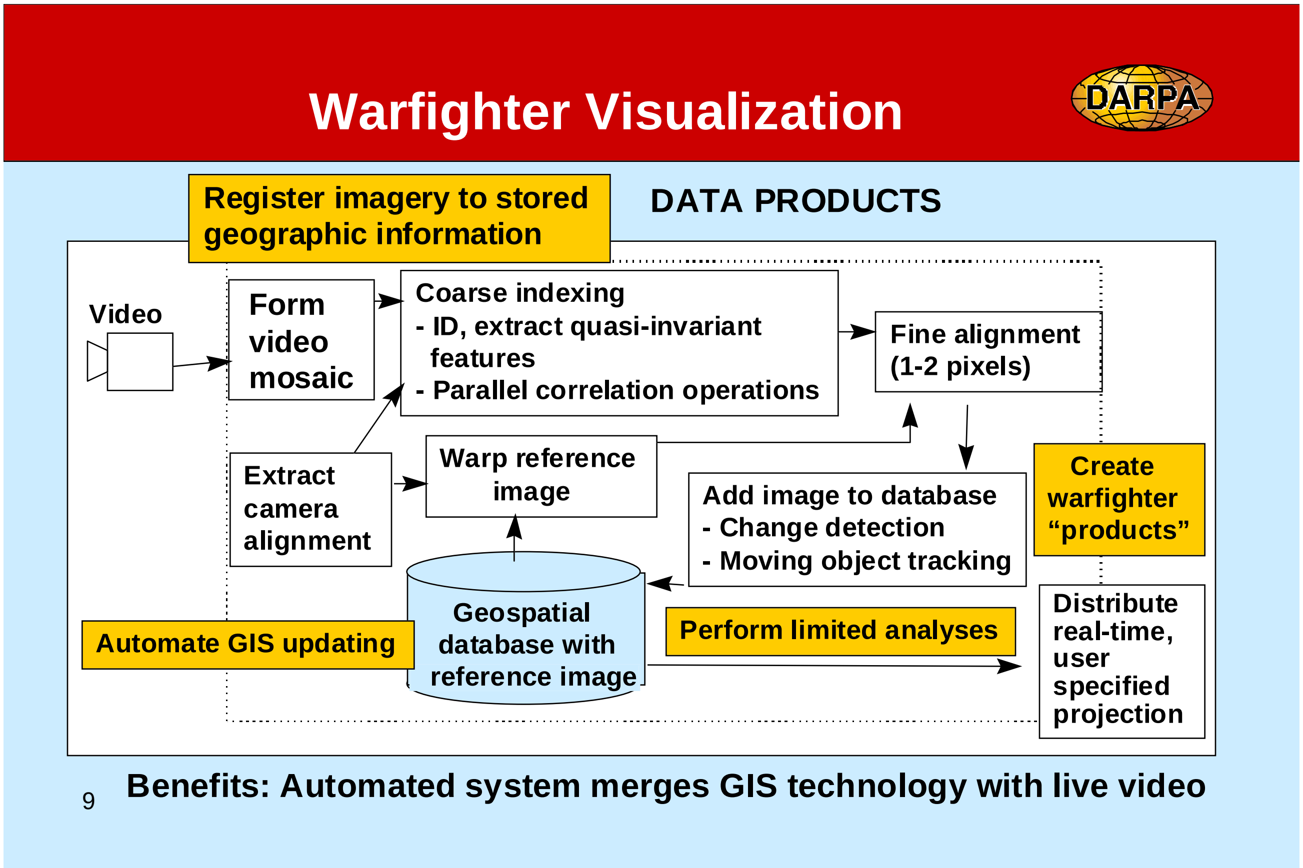
A 3-D site model is developed by merging available products with real-time sensor data collected from a locally operated aerial platform such as an Exdrone. Limited processing at the collection point will enable the live data feed to include intra-frame surveying; the system will automatically detect changes in the image and track moving objects. The system will automatically be able to produce real-time products developed through a set of user specific queries, including morphing the data and analyzing it from the user perspective. The user products will be defined so that they are compatible with a 3-D rendering system supported by a bodyworn augmented reality computer. Additional analysis required for mission functions that currently cannot be done automatically can be done with human interaction.



The users will interact with the system through the bodyworn augmented reality computer. Geospecific data that can be attributed to the individual’s surroundings, either static or event driven information, will be presented to the individual as if it were glued to the environment. Bodyworn sensors, currently visual, will collect information about local features and fixate on them for the purposes of maintaining proper orientation and stable registration with which to paste the information. The same sensors, with their ability to collect image data and relatively orient themselves, will also be used as data collection devices. Individuals will be capable of annotating the data, and through the local database will integrate their information with data collected from other user perspectives.



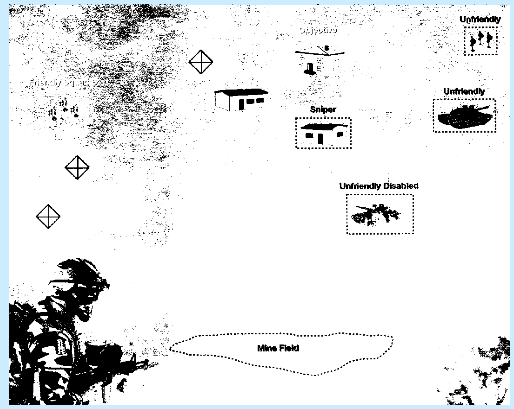
The real-time buildup of 3-D models will be accomplished using processing of an integrated set of sensors at the collection point. The imaging device filters points out of each frame that belong to a static feature. With GPS data for global positioning and with real-time IMU data to sense the sensors motion, the position of that feature is solved through epi-polar geometric techniques. This involves taking two pictures, filtering matching points, and then solving for the translation and rotation vectors to determine object positions. Locations of features within each frame will be solved for with survey accuracies (<1 mr and <1 m at 2 km range) in real-time. The key is integration of the image and IMU data in real-time using a complementary Kalman filter to obtain greater accuracies. This system will initially weigh about 11 lbs and could be mounted in helicopters, small UAVs such as Exdrones, or moving vehicles. Smaller image surveyors will be developed that can be rifle-mounted.



Collected imagery is used to build a geospatial database in areas where limited or no previous information exists. The system will be able to accept real-time video or "surveyed" video, rectify it and mosaic it to any existing spatially controlled image data available. Where imagery already exists, the Warfighter Visualization system registers its imagery to the stored geographic information, automatically updates the imagery database with new information, performs limited analyses and creates products to be exported to the warfighter as discussed earlier.

Warfighter Visualization

- Wearable system to superimpose data onto the real-world
  - Develop software visualization tools
- Image stabilization
  - Integrate INS/Kalman filter
  - Develop "smart camera" to estimate motion from optical flow
- Real-world registration
  - Develop inertial/optical hybrid tracker for tracking real-world features
- Mechanisms for collaborative updates
  - Enable manual updates with designation of known landmarks



Benefits: Wearable **INFORMATION** superimposed onto 3-D environment.

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A wearable augmented reality system will allow the individual to see information about his/her surroundings through graphical annotations or other cues that are pasted to features in the environment. This system will require new developments in optical tracking, techniques using both optical flow tracking and fixed feature tracking will be investigated. This system will also require further advancements in head-motion prediction and image stabilization. Finally, new applications for retrieving and presenting live situational information will be developed.

Warfighter Visualization

Focus on complex viewing requirements

- Low angle-of-attack
- Battlefield situations
- Urban terrain
- Temporal variations

Applications/Demonstrations to support individual warfighter and small teams.

Phase I Technology Goals

Real-time image/data collection	Real-time image/data blending	Real-time augmented reality/ visualization

Phase I focuses on the challenges of bringing a real-time site model buildup and utilization technologies to the individual warfighter in the most challenging environments, the low-angle of attack (even ground based perspective) and complex urban terrain. The focus is on a local system that could be taken to the field and utilized by a small team operating in a high tempo environment.

Warfighter Visualization

Phase I Participants

Visually Coupled Systems - Sarnoff Corporation,
CDI, Cambridge Research Associates

Geospatial Registration - NAVSYS Corporation,
Northeastern University

Enhanced Human Interfaces - Hughes Defense Systems,
Hughes Research Laboratory,
University of Southern California,
University of North Carolina

Warfighter Visualization

Future program focus is on embedded systems

- Processing at the collection point
- Information-based sensing of the environment
- Spatially coupled I/O

Continued focus on real-time operations.

Applications/demonstrations to support individual warfighter and small teams.

Phase 2 Technology Goals

Real-time sensor coupled processing	Real-time environment correlation	Real-time spatially-based I/O

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The program focus will be driven toward more capable embedded electronics systems. This will relieve the requirement for separate information systems for functions that pertain to situation awareness. These systems will be able to locate themselves automatically in the environment, as well as interpret data that is associated with features within the environment, even at high resolution.

This has begun with smarter cameras and other multispectral sensors that can automatically survey the locations of features within the image, as well as locate and record specific attributes that can set that feature apart from other features and/or the background.

Information-based sensing of the environment allows real-time association of data collected at a point with all other information known about that point. This includes stored information as well as other sensor data to solve a problem for some specific application.

Real-time spatially based I/O involves preserving the integrity of the location-based information in the form that it gets presented to the individual. This includes a variable focal distance display that shows visual augmented reality data in the proper focus, or provides the individual with spatial cues such as a motion-sense or noise that mimics a squirrel rustling bushes or acceleration-type pressure.